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STRATEGIC OPPORTUNITIES TO INCREASE THE IMPACT OF SCIENCE AND TECHNOLOGY IN REGIONAL DEVELOPMENT: OPEN INNOVATION AND THE STRATEGIC VALUE OF HORIZONTAL SOCIAL NETWORKS

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Abstract

This paper discusses the background to and theoretical grounding for the development of a collaborative project, initiated by the author with a local business-education foundation and two regional universities, to create a Web page based on the principles of open innovation to facilitate the transfer of science, technology and knowledge between disciplines and sectors to encourage innovation and development. It considers how open innovation can serve as a strategic device for overcoming organizational path dependence, vertical state and social hierarchies and embedded patron client relations, with the aim of achieving a greater role for science and technology in regional development in less favoured regions (LFR´s).

Keywords: Open innovation, knowledge transfer, horizontal networks, social capital, regional development

Introduction

Funding intersectorial collaboration projects is one of the strategies the Mexican government has used to address the challenge to increase the social appropriation of science and technology to favour national and regional development. Businesses are encouraged to work with research institutes and departments to develop innovations in diverse fields. In the knowledge economy open innovation has become a more valued part of the economic landscape: Pénin et al describe the following different forms of open innovation: "co-conception; innovation with customers, markets for ideas, crowdsourcing, open source, co-development, etc." They also observe that "opening the innovative boundaries of the firms also lead to changing regional innovative dynamics" (Pénin, Hussler y Burger-Helmchen 2011, 11,21). Manuel Castells has explored the role of new communication technologies in the creating a worldwide network of innovation systems (M. Castells 2001) (M. Castells 2002) (M. Castells 2002) A study, however, by the OECD on learning and innovation systems, whilst acknowledging the importance of regional innovation systems, also explored the barriers to the development of open innovation networks in certain regions. (OECD 2001)

To explore these barriers, they reflected upon the social aspect of institutions and organisations, concluding that "The interaction between the organisations comprising a network (or system) reflects not only market relationships but also the wider social and cultural context". The policy implications of this social aspect are that "markets are always institutionally embedded… these institutions are in part the unpremeditated product of long-

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term processes of civil and economic development… and may result in path-dependency". When such long term processes are taken into account, the nature of the barriers to the development of regional innovation systems stands out: "In less-favoured regions (LFRs)"the culture of command, hierarchy, and dependency…has stifled the formation of a reflexive culture among the majority of its economic institutions". They conclude that "the crucial issue is not whether policy makers should intervene or not, but rather what forms of intervention are likely to be most effective in actually existing situations" and that "What is much more complex, of course, is to specify how such regional institutional change is to be achieved". (OECD 2001)

In this study of the challenges to increase the social appropriation of science and technology in the southeast of Mexico, a systemic approach is applied. The systemic approach seeks long term sustainable solutions through the exploration of the multiple dimensions of the problem space (such as Social, technical, economic, political, physical cultural, others…) and the design of an enabling environment to successfully navigate those problems. (MIDDLEGROUND; LSE COMPLEXiTY 2012, 43). Findings from a recent regional research project on the Social Appropriation of Science, Technology and Innovation and also research undertaken by the author on the impact of reforms in Higher Education in Mexico were analysed through the heuristic framework of social capital to explore the problem space of this regional context.. The design of an enabling environment was based on the use of the open innovation model and innovations in Internet technology as an alternative strategy to challenge the structural challenges in the region.

Outline of the heuristic framework of Social Capital

In The Well-being of Nations, the CERI project of the OECD defines social capital as "*networks together with shared norms, values and understandings that facilitate co-operation within or among groups*." (OECD 2001, 41) Trust is considered to be both an outcome and source of social capital. Positive forms of social capital are based on strongly bonded groups which practice both inclusive *social bridging* and *linking*. The down-sides of social capital can emerge as the result of the negative effects of 'inward-seeking' strongly bonded groups and 'exclusive social bridging'.

Organisational "path dependence"

Robert Putnam is well known for his work on the declining social capital in the United States which he attributes to the breakdown of relations of trust as people engage ever less in community activities such as bowling, choir groups, etc. His research in civic traditions in modern Italy sought to explain why national policies have not overcome the diverging social and economicrealities of the northern and southern regions in Italy. He refers to the prevalence of 'tradition', in southern Italy and in Latin America, in terms of 'path dependence', which not only includes the idea of cultural resistance to external policy initiatives, but also the transformation of the intended outcomes of those policies: resulting from the fact that "informal norms and culture change more slowly than formal rules, and tend to remould those formal rules, so that the external imposition of a common set of formal rules will lead to widely divergent outcomes." (Putnam 1993)

Yet according to Putnam tradition is not merely the result of inertia, instead the informal rules which sustain tradition are themselves embedded in the hierarchically ordered organizations which reproduce traditions, concluding that "the Mafia or the institutional Catholic Church should be negatively associated with good government" as should patron-client relations and strong kinship ties. These reciprocal yet vertical and unequal relations "undermine the horizontal group organisation and solidarity of clients and patrons alike – but especially of the clients." (Putnam 1993)

Putnam recognises that such hierarchical structures do serve a purpose in the early stages of society by establishing stability, yet if not superseded in the appropriate moment of social development, they become themselves an obstacle. And so, it can be observed that in the north of Italy "civic equilibrium has shown remarkable stability … although its effects have been disrupted from time to time by exogenous forces like pestilence, war, and world trade shifts. The contrasting Hobbesian equilibrium in the South has been even more stable, though less fruitful." . Similarly kinship ties are important in the early stages of commercial revolution, but in later social development, such 'strong ties' are less important than weak ties which "encompass broad segments of society and thus undergird collaboration at the community level", Thus "Social context and history profoundly condition the effectiveness of institutions." (Putnam 1993)

When considering innovation and learning regions the OECD consider that "Such "path-dependency" may thus confine regions to development trajectories leading to low growth, decreasing employment, declining income levels and so forth". Clearly in less favoured regions (LFRs) alternative strategies to facilitate knowledge transfer need to be designed to circumvent the organizational path dependence "which may produce "lock-in" within a regional innovation system" (OECD 2001)

Vertical and horizontal social structures

Path dependence is a concept which can usefully be employed in explaining the resistance to public policies for institutional reform in Mexico (Adler Lomnitz 1994) During the seventies and eighties in Mexico, Larissa Adler Lominitz, a Chilean anthropologist, identified a combination of vertical and horizontal relations as typifying the structure of urban relations in Mexico City, and the structure of Mexican society in general. Horizontal reciprocal relations develop at all levels of society and increases social mobility and the circulation of resources between equals. Unlike the vertical interchange of resources based on formal groups, horizontal interchange takes place between "informal groups, without permanent or clearly defined frontiers. These horizontal networks extend across sector divisions, so it is common practice to use family and social connections to resolve bureaucratic requirements or legal issues.

Adler argues that both the private and public sector have interests in maintaining these horizontal networks, and this can be shown by the proliferation of these networks. Horizontal networks by introducing flexibility into the system allow the system to work for "they lighten the pressure of hierarchical relations and provide flexibility" They also avoid the system transforming itself into a "cast society in perpetual rivalry. (Adler Lomnitz 1994)

Horizontal social networks and new social media

Manuel Castells explains that horizontal networks whose strength "resides in their flexibility, adaptability and capacity for self-reconfiguration" have played an important social role since ancient times, yet have remained historically undocumented not only because vertical structures of power are more visible to historical record, but also because "when they exceed a certain size, complexity and volume of transactions, they become less efficient than the vertical structures of command and control, *in the existing conditions of pre-electronic communication"*. (M. Castells 2012)

This same fact explains why horizontal networks are becoming unexpectedly influential as developments in microelectronic forms of communication remove the material impediments to the flourishing of an integral form of social organization. Whilst the first forms of electronic communication such as the telegraph "had insufficient capacity to proportion autonomy to all the nodes of the network", it was the new communications

technologies which "liberated all the potentialities of the networks", namely flexibility, adaptability and survival capacity". (M. Castells 2012)

Castells suggests that another important aspect of new microelectronic forms of communication is the autonomy from social institutions which they facilitate, an important factor in the survival of networks and the confidence individuals have in their use: "*there is a more profound fundamental connection between the Internet and the social network movements; they share a specific culture, the culture of autonomy, the fundamental cultural matrix of contemporary societies"*. (M. Castells 2012)

It may be asked what kind of autonomy is referred to by Castells. In the case of the Internet it is the autonomy of social networks, and could therefore be described as a synergic autonomy. Synergic autonomy can be compared and differentiated to the notion of embedded autonomy used by Michael Woolcock. (Woolcock 1998)

Linear and complex models of the science-society relation

The model of the relation of science and technology to society is also changing. Researchers in the OECD CERI project argue that investment in science and technology in higher education institutions and research centres does not guarantee greater levels of innovation. Indeed they observe that this linear model is "the exception instead of the rule" although "a prejudice still exists in this direction" (OECD 2004)

New models are based on a systemic approach which considers the complex relationships between organisations. Rosalba Casas (Casas (Coord.) 2001), and Matilde Luna (Luna (Coord.) 2003) and collaborators have analysed the problem of business-academic relations in Mexico from the perspective of the formation of knowledge networks. Ana María Barañano considers that "Innovation is a complex technological, sociological and economic process that involves a web of extremely intricate innovations, not only within the firm but between firms and between the firm and its economical, technical, competitive and social environment" (Barañano 2007). Sagasti considers the level of relations between different sectors as an indicator of the level of development of a society (Sagasti 2011), whilst Katz considers the lack of relations between organizations as one of the key factors explaining underdevelopment in México (Katz 2007).

If, as suggested, networks are the rule rather than the exception in the relation between science, technology and society, yet a situation of weak intersectorial relations predominates in the region, then clearly strategies which address this problem are urgently required. The following research findings indicate the principal elements which such a strategy must address.

Findings and interpretation

Identifying the contours and elements of the problem space

The variable of open innovation was initially compared to demographics and economic performance across different sectors and then subject to further analysis to determine the impact of three independent variables: social networking across sectors; levels of knowledge management in HE and R&D centres; forms of social capital in the region.

Open innovation and regional development

With the objective of redressing the low levels of development in the South-East region of México, in 2010 a 30 month research project entitled "The Social Appropriation of Science, Technology and Innovation in the South" was financed by the Mexican National Council for Science and Technology (CONACYT). The following economic indicators were cited to justify the urgency of the project:

- GDP: This region contributes only 6.8% of the national average, as compared with 41.2% by the central region and 19.6% by the northern region.
- National Resource for R & D. The region was awarded only 4% of the national resources available in 2007 whilst the centre was awarded 65.4%

A comparative analysis of the results of 10 of the theses produced during the study were analysed by the author against the background of six regional seminars (Russell Archer y Barroso Tanoira 2012)

Demographic and economic contours

Economic data for the 6 states of the south-east region, presented in a study by the author of the impact of a public programme to promote collaborative innovation between the academic and business sector (Programa Estimulación a la Innovacion - PEI) , showed low population density and small scale manufacturing sectors:

A low population density prevails, the largest state of Veracruz has a density of over 7.5 million and the smallest, Campeche, less than one million. Nevertheless, this smallest state is the second highest contributor in the region to GDP (3.2%), after Veracruz (4.7%) If state GDP is analysed by sector, then it becomes clear that in Campeche over 80% of the state wealth production is in the secondary sector. Yet, in Campeche 74.81 % of that production is in mining (oil and gas) and only 0.86 % in manufacturing, whereas in the states of Veracruz and Yucatan the predominant production comes from manufacturing. (Russell y Canul 2012)

Identifying correlation between open-innovation and levels of R&D

The higher amounts of government funding for open innovation projects between business sectors and academic institutions appears coupled in the states of Veracruz and Yucatan with higher levels of industrial manufacturing, tentatively establishing an apparent correlation between economic development in the manufacturing sector and levels of participation in open innovation projects. As a consequence, *the question arose as to how in states where activities are based primarily on the extraction of primary sources, projects such as PEI to stimulate open-innovation can have a greater impact in expanding manufacturing activities as a percentage of GDP*. Firstly it was necessary to determine whether other variables have an impact in the region.

Levels of networking across sectors in open innovation projects in the region

The study of the impact of the PEI in the cities of Merida, Campeche and Carmen (in the States of Campeche and Yucatan), from 2010 to 2011 included both quantitative and qualitative analysis of networking dynamics between sectors and public funding for innovation projects. The analysis of the results from the quantitative section of this study, showed that there was a direct relation between the level of business-government-academic networking and public funding of a project: the higher the levels of collaboration the more likely the project was approved. Nevertheless, the analysis of the qualitative section of this study showed that although the business community considers that his type of funding programme to be highly pertinent, they consider collaboration between sectors in open innovation projects to be very low.

The results in Campeche and Yucatan were found to be similar to a study of the Social Appropriation of knowledge in business organizations in the State of Quintana Roo by Adriana Valdivieso in which she identified the following:

a) A positive factor was business orientated local and federal programmes

b) A negative factor was the lack of collaboration between the business and the academic sector. (Valdivieso Ortiz 2012)

A further study in the state of Yucatán of experiences in the generation, diffusion and use of knowledge in Social and Productive Institutions by Nayeli Araiza found that there was little external transferral of knowledge, internal transferral predominated. (Russell Archer y Barroso Tanoira 2012)

Knowledge management in H.E. and R&D centres

Knowledge management in the study of public funding exercise PEI in Campeche was also cited as a factor for low levels of collaboration across sectors. The business community considers collaboration between sectors in open innovation projects is very low for the following reasons:

- Knowledge gaps within institutions of their own production in science and technology
- Low levels of interest, on the most part, in analysing collaboration and open innovation opportunities
- As a result there is little diffusion of information about their research programmes
- Their networking practices are limited to traditional areas of student activities in social service and professional practice

A study of the implementation of a knowledge management data base in the Autonomous University of Campeche registered the institutional resistance to the concept and its implications. (2011) The project was abandoned after 2 years. The results in Campeche coincide with studies in other states in the region.

Jessica Ramos, another of the undergraduate students participating in the regional project, with a study of "The social appropriation of science and innovation. Experiences in the generation, diffusion y use of scientific knowledge in institutions of H.E. and research centres in the state of Yucatán", found that efficient practices of knowledge management were confined to a limited number of institutions. A similar study "Diagnosis of the Generation of science and Technology by research Centres in the State of Quintana Roo" by Viridiana Ortega arrived a similar conclusions. (Russell Archer y Barroso Tanoira 2012)

All four studies registered that the lack of knowledge management in H.E. and R&D centres as a negative factor in following through open-innovation initiatives.

Means of networking in the region

The study of public funding exercise PEI in Campeche also documented that when collaboration was achieved it was mainly through informal social networks: One businessman related that having unsuccessfully attempted to initiate an open innovation project with the Technical College in Merida through their outreach department which had informed him that the college did not pursue research in the area in question, was subsequently advised by a friend that heshould obtain an appointment with the Principal of the college; resulting in a very successful and on-going collaboration in open innovation. Variations of this example were recurrent in the study´s findings and also mentioned in the other studies cited above. When formal collaboration procedures floundered it was informal social networking that took the project forward.

Concluding remarks on findings and their interpretation

A preliminary analysis of economic data indicated a correlation between economic development in the manufacturing sector and participation in publicly funded open innovation projects, yet further analysis revealed additional variables to be involved:

- Low levels of knowledge management within H.E. and research institutions
- Inadequate functioning of outreach departments
- The positive relation between cross sector collaboration and achieving public funds for open innovation projects

- Low levels of formal cross sector collaboration
- Predominance of use of horizontal social networks
- Low levels of trust in the integrity of government institutions and hence operational integrity of funding procedures

These findings are evidence of the predominance in the region of the first and second forms of social capital as defined by the OECD, namely strong group bonding and vertical linking and the absence of the third form of cross sector bridging. Organizational path dependence and the low levels of trust which predominate in the region are often circumvented by informal horizontal social networks, thus this solution depends on individual social networks often accessed on the basis of ad-hoc encounters.

The design of an enabling environment

management, effective outreach departments, institutional integrity and horizontal social networks were all identified as important factors in open innovation and regional development, but the question remained as to how they could be leveraged. The OECD challenge that "the crucial issue is not whether policy makers should intervene or not, but rather *what forms of intervention are likely to be most effective in actually existing situations*." (OECD 2001) remained unanswered.

The response was the design of a strategy to promote open innovation through a Science-Knowledge-Society Web page. The author, formed an interdisciplinary, inter-sectorial group, with the local business-education foundation of which she is member and technical advisor since 1999, one public and one private regional university, to development of a Science-Knowledge-Society Web page based on the principles of open innovation to facilitate the transfer of knowledge between sectors to encourage innovation and development. The project achieved finance from the Mexican National Council for Science & Technology and the Society for the Divulgation of Science & Technology.

The objective of creating an environment based on the concepts of autonomy and synergy which function as the principle upon which the construction of horizontal knowledge networks is facilitated, constituted the basis of the design. The objectives were i) to enable open innovation and regional development; ii) to better identify diverse social and different regional needs and issues; iii)to promote the participation of citizens in science monitoring and discussion groups, iv)to promote the participation, mobility and employment of young researchers; v) to promote the participation of local and regional ethnic groups to build bridges between traditional knowledge and modern science in the solution of regional issues.

New technologies of cloud computing and VPS dedicated servers were used to facilitate the creation of autonomous and synergic environments. Registration and participation would on an individual basis, in line with the underlying principles of autonomy of the project, to encourage the construction of horizontal networks in a region where a culture of vertical structures of authority predominate, at social and organizational levels, hindering innovation. Users would be required to enter only a minimum level of identification and further content will be optional, nevertheless they are recommended to include sufficient information in their profile relevant to the relations and networking they wish to achieve, as it is this information that other users will be able to access when considering the options that the system will produce concerning with whom to initiate direct communication according to individual areas of experience and interest. The end users would also be encouraged to participate, or initiate discussion groups according to topics of interest where they will also be able to identify end-users. Analysis of successful networking and innovation experiences will be posted on the site.

During the trial stage (May-June 2013), access to use the data base was available via invitation only, or on request: http://www.cienciasabersociedad.org.mx/. The results of the

user evaluation confirmed the need for redesign of the user interface to appeal more successfully to a cross sector user cohort of clients and the refinement of the data base classification systems.

Conclusion

The analysis of empirical research clearly identified the positive impact in regional development of the appropriation of science and technology through open-innovation projects, particularly when it involved cross sector collaboration and consequently the pertinence of public funding of such initiatives. Nevertheless, it also revealed the existence of regional challenges to achieve the necessary networks of collaboration and hence the need for the design of alternative strategies to achieve this goal. The strategy analysed indicates that autonomous Web sites supported by public funds could provide an option to bridge the gap by providing a means of the management of information, facilitating the building of social networks and encouraging knowledge transfer to enable regional development.

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